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Alamogordo Reservoir (Sumner Lake) DeBaca and Guadalupe Counties New Mexico

National Eutrophication Survey, Las Vegas, Nev.

Prepared for

Environmental Monitoring and Support Lab., Las Vegas, Nev.

Jul 77

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NATIONAL EUTROPHICATION SURVEY

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT

ON

ALAMOGORDO RESERVOIR
(SUMNER LAKE)

DE BACA AND GUADALUPE COUNTIES

NEW MEXICO

EPA REGION VI

WORKING PAPER No. 817

WITH THE COOPERATION OF THE

NEW MEXICO ENVIRONMENTAL IMPROVEMENT AGENCY

AND THE

NEW MEXICO NATIONAL GUARD

JULY, 1977

REPORT ON ALAMOGORDO RESERVOIR

DE BACA AND GUADALUPE COUNTIES, NEW MEXICO

EPA REGION VI

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 817

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the New Mexico Environmental Improvement Agency for professional involvement, to the New Mexico National Guard for conducting the tributary sampling phase of the Survey, and to those New Mexico wastewater treatment plant operators who provided effluent samples and flow data.

The staff of the Surveillance Section, Water Quality Division, New Mexico Environmental Improvement Agency provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

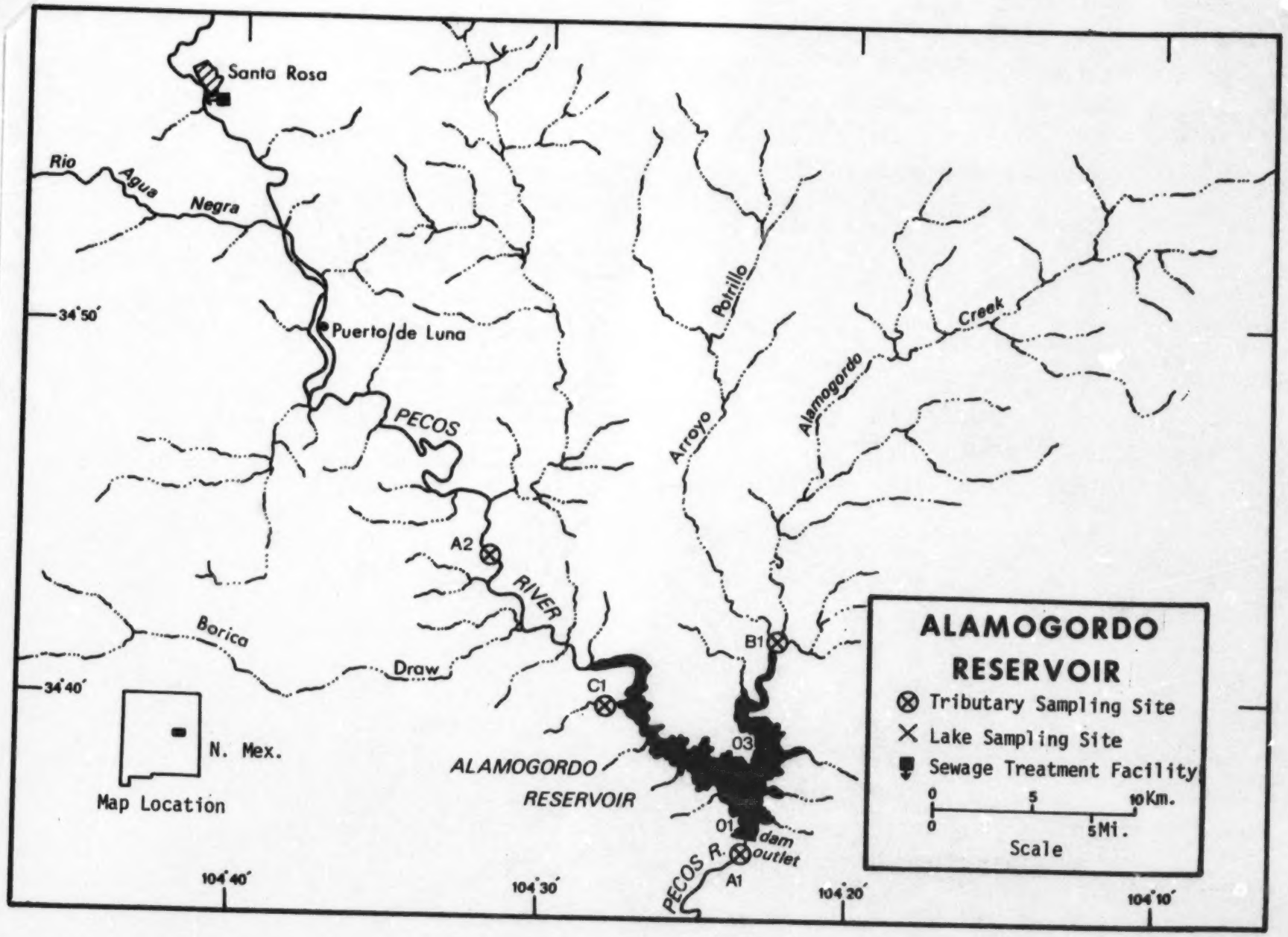
Brigadier General Franklin E. Miles, the Adjutant General of New Mexico, and Project Officer Colonel Marvin D. Bohannon, who directed the volunteer efforts of the New Mexico National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

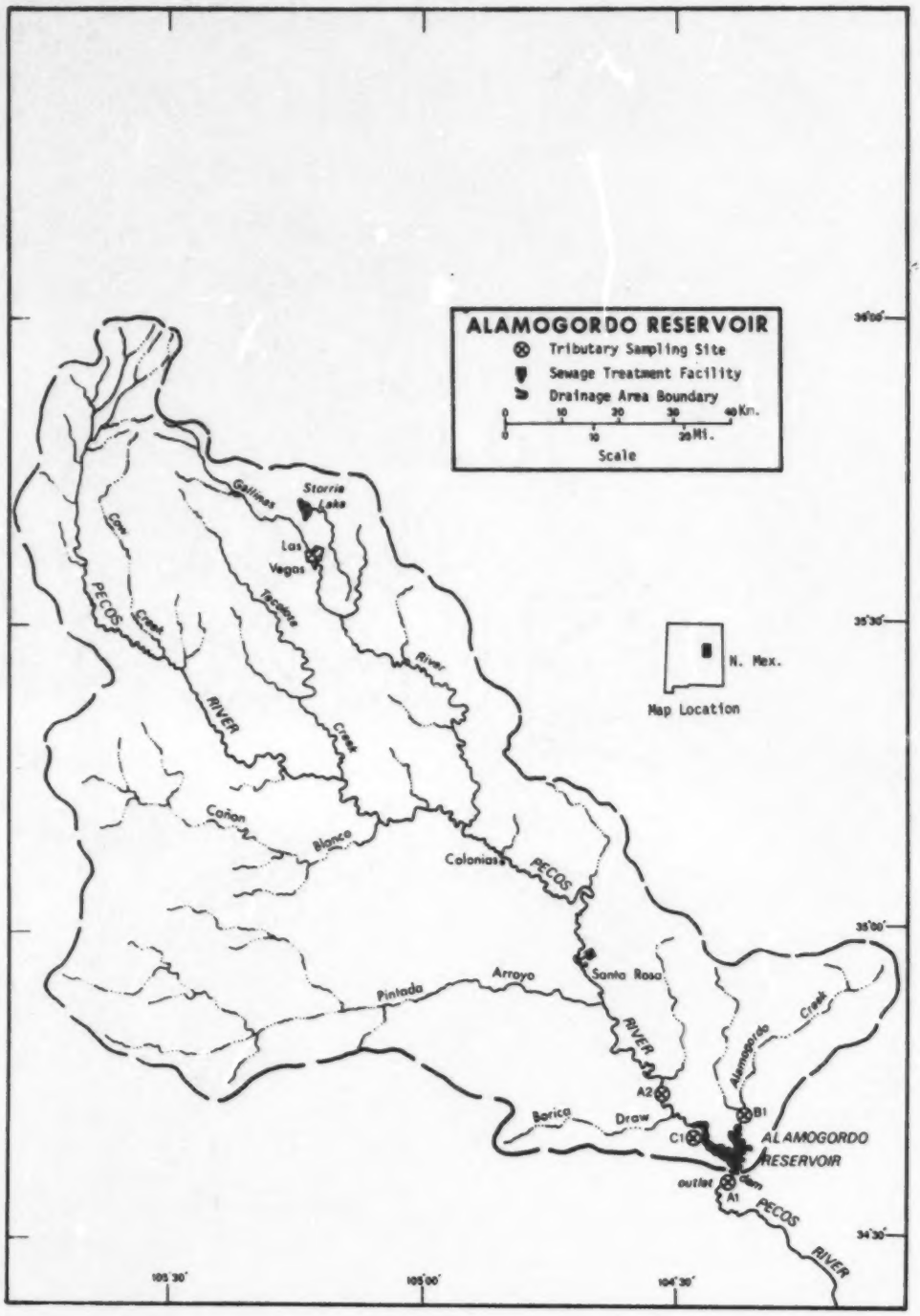
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF NEW MEXICO

LAKE NAME	COUNTY
Alamogordo Reservoir (Sumner Lake)	De Baca, Guadalupe
Bluewater Lake	Valencia, McKinley
Conchas Reservoir	San Miguel
Eagle Nest Lake	Colfax
Elephant Butte Reservoir	Sierra
El Vado Reservoir	Rio Arriba
Lake McMillan	Eddy
Ute Reservoir	Quay


Santa Rosa
Rio
Agua
Negra
34°50'
Puerto de Luna
PECOS
RIVER
A2
Borica
Draw
34°40'
N. Mex.
Map Location
C1
ALAMOGORDO
RESERVOIR
Potrillo
Arroyo
Alamogordo
Creek
B1
03
01
dam
outlet
PECOS R.
A1
104°40'
104°30'
104°20'
104°10'
ALAMOGORDO
RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 5 10Km.
0 5Mi.
Scale


ALAMOGORDO RESERVOIR
Tributary Sampling Site
Sewage Treatment Facility
Drainage Area Boundary
0 10 20 30 40 Km.
0 10 20 Mi.
Scale
N. Mex.
Map Location
Storrie Lake
Las Vegas
Gallinas
Gage
PECOS
Creek
Tecolote
River
RIVER
Creek
Cañon
Blanco
Colonias
PECOS
Santa Rosa
Pintada
Arroyo
RIVER
Alamogordo
Creek
A2
B1
C1
Borica
Draw
ALAMOGORDO
RESERVOIR
outlet
Dam
A1
PECOS
RIVER
36°00'
35°30'
35°00'
34°30'
105°30'
105°00'
104°30'

REPORT ON ALAMOGORDO RESERVOIR, NEW MEXICO

STORET NO. 3501

I. CONCLUSION

A. Trophic Condition:*

Based upon Survey data, Alamogordo Reservoir is considered early eutrophic. However, biological response as measured by chlorophyll a values (range of 1.9 µg/l to 10.7 µg/l, mean of 5.9 µg/l) is more typical of that observed in mesotrophic water bodies. Potential for primary production as measured by algal assay control yield was moderate in the lake samples. Nutrient levels in the lake were moderately high: of the nine New Mexico lakes sampled in 1975 (including Navajo Reservoir), six had higher median total phosphorus levels (0.025 mg/l), five had higher median inorganic nitrogen values (0.050 mg/l), and eight had higher median orthophosphorus levels (0.003 mg/l) than Alamogordo Reservoir.

Survey limnologists did not report any problem macrophytes or algal growths during their visits to the lake. However, they did note the high turbidity in the reservoir, and the low Secchi disc visibility observed (range of 0.3 m to 1.2 m) suggests that primary production in Alamogordo Reservoir is light- rather than nutrient-limited. Other sources (New Mexico Water Quality Control Commission, 1975) report that there is no permanent

*See Appendix E.

pool in this lake which is used for irrigation in the Carlsbad area, and that lake drawdown periodically results in moderate fish kills.

B. Rate-Limiting Nutrient:

Algal assay results indicate that Alamogordo Reservoir was limited by available phosphorus levels during the fall sampling period. The lake data suggest primary limitation by phosphorus in the summer and fall, and nitrogen limitation during spring.

C. Nutrient Controllability:

1. Point sources -

During the sampling year, a single point source, the city of Santa Rosa, contributed 9.3% of the total phosphorus load to Alamogordo Reservoir.

The calculated annual phosphorus loading of 1.52 g $P/m^2/yr$ for the reservoir is approximately four times that proposed by Vollenweider (1975) as "eutrophic" for a lake with such volume and hydraulic retention time. Although Vollenweider's model certainly is not applicable to a lake with fluctuating volume such as Alamogordo Reservoir, other studies (New Mexico Water Quality Control Commission, 1975; New Mexico Environmental Improvement Agency, 1974) indicate that the lake is generally considered to be nutrient rich and highly productive. Additional sampling is needed to determine whether the excessive nutrient levels reported in these past studies are typical for

Alamogordo Reservoir, and to better define the sources of nutrient input into the lake.

2. Nonpoint sources -

Nonpoint sources, including precipitation, contributed 90.7% of the total phosphorus loading to Alamogordo Reservoir. The Pecos River contributed 87.7% of the total loading. The New Mexico Environmental Improvement Agency (1974) has recommended a comprehensive sampling program for the Pecos River, which drains not only the nutrient rich Upper Sonoran Region, but also receives some irrigation return flows. They have also suggested the need for obtaining state water rights in order to establish a minimum pool for the reservoir.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake morphometry data were provided by Martin and Hanson (1966) and Tony Drypolcher (personal communication). Tributary flow data were provided by the New Mexico District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by mean flow of the outlet. Precipitation values are estimated by methods as outlined in the National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 18.49 km^2.
2. Mean depth: 8.1 meters.
3. Maximum depth: 19.8 meters.
4. Volume: 150.609 x 106 m^3.
5. Mean hydraulic retention time: 629 days (1.7 yr)

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area (km^2)	Mean Flow (m^3/sec)
A-2 Pecos River	10,282.3	2.54
B-1 Alamogordo Creek	802.9	0.16
C-1 Unnamed Tributary	22.8	0.01
Minor tributaries and immediate drainage -	242.1	0.06
Total	11,350.1	2.77
2. Outlet - A-1 Pecos River	11,370.1	2.77

C. Precipitation:

1. Year of sampling: 30.6 cm.
2. Mean annual: 34.5 cm.

III. LAKE WATER QUALITY SUMMARY

Alamogordo Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of depths at each station (see maps, pp.v-vi). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the last visit, an 18.9-liter depth-integrated sample was composited for algal assays. Maximum depths sampled were 10.7 meters at Station 01, 7.6 meters at Station 02, and 4.6 meters at Station 03. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

DET CODE 3501

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(5/ 1/75) S*** = 3 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(8/20/75) S*** = 3 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(10/ 2/75) S*** = 3 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	6	12.7- 13.5	13.2	0.0- 1.5	6	21.8- 25.3	23.6	0.0- 1.5	6	18.1- 18.9	18.8	0.0- 1.5
MAX DEPTH**	3	12.7- 13.5	13.2	4.6- 7.6	3	20.5- 23.5	22.0	3.7- 7.9	3	18.1- 18.8	18.6	1.5- 10.7
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	6	8.0- 9.2	8.2	0.0- 1.5	6	6.4- 8.2	6.8	0.0- 1.5	6	6.6- 7.8	7.3	0.0- 1.5
MAX DEPTH**	3	8.2- 8.2	8.2	4.6- 7.6	3	4.4- 4.8	4.6	3.7- 7.9	3	6.2- 7.8	7.4	1.5- 10.7
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	6	1940.-2020.	1963.	0.0- 1.5	6	2165.-2305.	2250.	0.0- 1.5	5	1521.-1617.	1567.	0.0- 1.5
MAX DEPTH**	3	1938.-2019.	1956.	4.6- 7.6	3	2077.-2204.	2135.	3.7- 7.9	3	1553.-1616.	1582.	1.5- 10.7
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	6	7.9- 8.2	8.0	0.0- 1.5	6	7.8- 8.2	7.9	0.0- 1.5	6	8.1- 8.2	8.2	0.0- 1.5
MAX DEPTH**	3	8.0- 8.1	8.0	4.6- 7.6	3	7.8- 7.9	7.9	3.7- 7.9	3	8.1- 8.2	8.2	1.5- 10.7
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	6	117.- 119.	118.	0.0- 1.5	6	97.- 105.	104.	0.0- 1.5	6	106.- 123.	108.	0.0- 1.5
MAX DEPTH**	3	117.- 119.	117.	4.6- 7.6	3	102.- 107.	107.	3.7- 7.9	3	106.- 122.	108.	1.5- 10.7
TOTAL P (MG/L)												
0.-1.5 M DEPTH	6	0.014-0.032	0.017	0.0- 1.5	6	0.024-0.036	0.029	0.0- 1.5	6	0.022-0.051	0.030	0.0- 1.5
MAX DEPTH**	3	0.014-0.018	0.014	4.6- 7.6	3	0.034-0.040	0.039	3.7- 7.9	3	0.026-0.050	0.031	1.5- 10.7
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	6	0.004-0.020	0.005	0.0- 1.5	6	0.002-0.005	0.003	0.0- 1.5	6	0.002-0.004	0.002	0.0- 1.5
MAX DEPTH**	3	0.003-0.012	0.004	4.6- 7.6	3	0.002-0.003	0.003	3.7- 7.9	3	0.002-0.003	0.002	1.5- 10.7
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	6	0.020-0.040	0.020	0.0- 1.5	6	0.020-0.020	0.020	0.0- 1.5	6	0.040-0.060	0.040	0.0- 1.5
MAX DEPTH**	3	0.020-0.020	0.020	4.6- 7.6	3	0.020-0.030	0.020	3.7- 7.9	3	0.040-0.050	0.040	1.5- 10.7
AMMONIA (MG/L)												
0.-1.5 M DEPTH	6	0.020-0.030	0.020	0.0- 1.5	6	0.020-0.020	0.020	0.0- 1.5	6	0.020-0.040	0.035	0.0- 1.5
MAX DEPTH**	3	0.020-0.030	0.030	4.6- 7.6	3	0.040-0.080	0.040	3.7- 7.9	3	0.020-0.060	0.020	1.5- 10.7
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	6	0.200-0.500	0.300	0.0- 1.5	6	0.200-0.300	0.250	0.0- 1.5	6	0.400-0.600	0.400	0.0- 1.5
MAX DEPTH**	3	0.200-0.300	0.200	4.6- 7.6	3	0.200-0.400	0.300	3.7- 7.9	3	0.300-0.600	0.400	1.5- 10.7
SECCHI DISC (METERS)												
	3	0.7- 1.2	1.1		3	0.3- 0.9	0.8		3	0.4- 0.8	0.8	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
05/01/75	1. Chroomonas ?	759
	2. Ankistrodesmus	715
	3. Raphidiopsis	223
	4. Cryptomonas	40
	Other genera	--
	Total	1,737
08/20/75	1. Raphidiopsis	395
	2. Nitzschia	395
	3. Oscillatoria	346
	4. Oocystis	197
	5. Cryptomonas	148
	Other genera	840
	Total	2,321
10/02/75	1. Chroomonas ?	979
	2. Flagellate	793
	3. Dactylococcopsis	746
	4. Microcystis	746
	5. Merismopedia	670
	Other genera	2,828
	Total	6,762

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
05/01/75	01	2.4
	02	2.0
	03	1.9
08/20/75	01	7.8
	02	8.9
	03	5.1
10/02/75	01	5.2
	02	10.7
	03	8.8

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked - 10/02/75

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.010	0.120	0.4
0.05 P	0.060	0.120	6.5
0.05 P + 1.0 N	0.060	1.120	21.3
1.00 N	0.010	1.120	0.4

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential for primary productivity in Alamogordo Reservoir was moderate at the sample collection time (10/02/75). A significant increase in yield over that of the control occurred when phosphorus was added alone and in combination with nitrogen, indicating phosphorus limitation. Nitrogen spikes alone did not result in an increase in growth beyond control yields.

The mean inorganic nitrogen to orthophosphorus ratios (N/P) in the lake data were approximately 6/1, 18/1 and 25/1 in the spring, summer and fall, respectively, suggesting primary limitation by nitrogen in the spring and phosphorus limitation in the summer and fall (a mean N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the New Mexico National Guard collected monthly near-surface grab samples from Stations A-1 and A-2 indicated on the maps (pages v-vi), except for the high runoff months of April and May when two samples were collected. Sampling was begun in December 1974, and was completed in November 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New Mexico District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in kg/km^2/year in Pecos River, at Station A-2 and multiplying the means by the ZZ area in km^2.

The operator of the Santa Rosa wastewater treatment plant provided monthly effluent samples and corresponding flow data.

A. Waste Sources:

1. Known municipal -

Name	Pop.* Served	Treatment*	Mean Flow ($m^3/d \times 10^3$)	Receiving Water
Santa Rosa	2,500	Trickling Filter	0.761	Pecos River

2. Known industrial - None

*Provided by treatment plant operator.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source		kg P/yr	% of total
a.	Tributaries (nonpoint load) -		
	A-2 Pecos River	24,605	87.7
b.	Minor tributaries and immediate drainage (nonpoint load) -	485	1.7
c.	Known municipal STP's -		
	Santa Rosa	2,625	9.3
d.	Septic tanks* -	20	0.1
e.	Known industrial - None		
f.	Direct precipitation** -	325	1.2
	Total	28,060	100.0%

2. Outputs - A-1 Pecos River 3,580

3. Net annual P accumulation - 24,480

*Estimate based on 75 lakeshore residences.
**Estimated (See NES Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Pecos River	84,990	72.3
b. Minor tributaries and immediate drainage (nonpoint load) -	1,935	1.6
c. Known municipal STP's -		
Santa Rosa	9,920	8.4
d. Septic tanks* -	800	0.7
e. Known industrial - None		
f. Direct precipitation** -	19,960	17.0
Total	117,605	100.0%

2. Outputs - A-1 Pecos River 68,495

3. Net annual N accumulation - 49,110

*Estimate based on 75 lakeshore residences.
**Estimated (See NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Pecos River	2	8

E. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotrophic" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A "mesotrophic" loading would be considered one between "eutrophic" and "oligotrophic".

Note that Vollenweider's model may not apply to lakes with short hydraulic retention times or in which light penetration is severely restricted by high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading (g/m^2/yr)
Estimated loading for Alamogordo Reservoir	1.52
Vollenweider's "eutrophic" loading	0.43
Vollenweider's "oligotrophic" loading	0.22

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR NEW MEXICO 12/16/76

LAKE CODE 3501 ALAMOGORDO RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 11370.1

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEA
3501A1	11370.1	1.02	0.57	0.79	1.81	5.21	6.97	4.05	6.09	3.48	2.12	0.34	0.62	2.7
3501A2	10282.3	0.91	0.54	0.74	1.76	4.87	6.80	3.40	5.38	3.11	1.93	0.31	0.59	2.5
350181	802.9	0.001	0.016	0.016	0.040	0.224	0.040	0.595	0.538	0.241	0.142	0.017	0.001	0.19
3501C1	22.8	0.0	0.001	0.001	0.002	0.008	0.001	0.057	0.028	0.018	0.007	0.001	0.0	9.0
3501ZZ	261.6	0.023	0.013	0.018	0.042	0.119	0.161	0.093	0.139	0.079	0.048	0.008	0.014	0.0

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 11370.1
SUM OF SUB-DRAINAGE AREAS = 11369.6

TOTAL FLOW IN = 33.08
TOTAL FLOW OUT = 33.07

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3501A1	12	74	0.018	7	0.003				
	1	75	0.021	9	0.024				
	2	75	0.025	14	0.014				
	3	75	1.303	13	0.048				
	4	75	1.841	7	2.520	29	2.520		
	5	75	2.775	12	2.464	28	2.973		
	6	75	28.317	17	31.998				
	7	75	4.757	16	2.294				
	8	75	2.265	13	2.803				
	9	75	2.180	16	2.209				
	10	75	2.549	20	2.549				
	11	75	0.015	11	0.028				
3501A2	12	74	2.917	7	2.860				
	1	75	2.718	9	3.002				
	2	75	2.549	14	2.549				
	3	75	2.549	13	3.908				
	4	75	4.616	7	1.954	29	7.730		
	5	75	6.966	12	4.304	28	7.447		
	6	75	5.748	17	5.295				
	7	75	10.902	10	2.662				
	8	75	2.379	13	1.841				
	9	75	5.210	16	6.456				
	10	75	2.379	20	2.435				
	11	75	2.633	12	2.549				

APPENDIX B
ATMO AIR TRIBUTARY

TRIBUTARY FLOW INFORMATION FOR NEW MEXICO 12/16/76

LAKE CODE 3501 ALAMOGORDO RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
350181	12	74	0.007						
	1	75	0.003						
	2	75	0.076						
	3	75	0.057						
	4	75	0.105						
	5	75	0.311						
	6	75	0.034	17	0.031				
	7	75	1.897						
	8	75	0.238						
	9	75	0.396	16	0.0				
	10	75	0.176	20	0.0				
	11	75	0.142	12	0.0				
3501C1	12	74	0.0						
	1	75	0.0						
	2	75	0.004						
	3	75	0.003						
	4	75	0.006	7	0.003				
	5	75	0.011	12	0.007				
	6	75	0.005	17	0.005				
	7	75	0.181	10	0.045				
	8	75	0.012						
	9	75	0.012	16	0.014				
	10	75	0.005	20	0.005				
	11	75	0.006	12	0.0				
3501ZZ	12	74	0.068						
	1	75	0.071						
	2	75	0.062						
	3	75	0.062						
	4	75	0.110						
	5	75	0.170						
	6	75	0.136						
	7	75	0.311						
	8	75	0.062						
	9	75	0.133						
	10	75	0.059						
	11	75	0.068						

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

350101
34 36 30.0 104 22 25.0 3
ALAMOGORDO
35011 NE* MEXICO

/TYPA/AMBNT/LAKE

11EPALES 760109 04001002
0023 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/05/01	10 35	0000	12.9	8.2	48	1966	8.10	118	0.020	0.500	0.020K	0.013
	10 35	0005	12.7	8.2		1959	7.90	117	0.020K	0.200	0.020K	0.006
	10 35	0015	12.7	8.2		1956	7.90	117	0.020	0.200K	0.020K	0.004
	10 35	0020	12.7	8.2		1956	8.10	119	0.030	0.200K	0.020K	0.012
75/08/20	15 30	0000	23.4	7.0	36	2270	7.80	104	0.020K	0.200	0.020K	0.004
	15 30	0005	21.8	6.4		2165	7.80	105	0.020	0.200	0.020K	0.002
	15 30	0015	21.2	5.8		2117	7.75	108	0.040	0.300	0.020K	0.002
	15 30	0026	20.5	4.8		2077	7.80	107	0.040	0.200	0.020K	0.002
75/10/02	15 10	0000	18.1	7.0	30	1521	8.20	106	0.040	0.400	0.060	0.003
	15 10	0005	18.1	6.6			8.10	108	0.040	0.400	0.050	0.002
	15 10	0015	18.1	6.6		1547	8.10	106	0.040	0.200	0.050	0.003
	15 10	0035	18.1	6.2		1582	8.10	106	0.060	0.300	0.050	0.003

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT RFMNING PERCENT
75/05/01	10 35	0000	0.025	2.4	
	10 35	0005	0.017		
	10 35	0015	0.014		
	10 35	0020	0.014		
75/08/20	15 30	0000	0.026	7.8	
	15 30	0005	0.024		
	15 30	0015	0.024		
	15 30	0026	0.034		
75/10/02	15 10	0000	0.023	5.2	
	15 10	0005	0.022		
	15 10	0015	0.021		
	15 10	0035	0.031		

K VALUE KNOWN TO BE LESS
THAN INDICATED

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

350102
34 38 08.0 104 23 37.0 3
ALAMOGORDO
35011 NEW MEXICO

/TYPA/AMBNT/LAKE

11EPALES 760109 04001002
0025 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/05/01	11 00	0000	13.2	9.2	45	1940	8.20	118	0.030	0.400	0.020K	0.020
	11 00	0005	13.2	8.0		1940	8.10	117	0.020K	0.200	0.020K	0.005
	11 00	0015	13.4	8.2		1940	8.10	118	0.020K	0.200K	0.020K	0.004
	11 00	0025	13.2	8.2		1938	8.00	117	0.020K	0.200K	0.020K	0.004
75/08/20	15 50	0000	23.3	6.6	13	2247	7.90	104	0.020K	0.300	0.020K	0.003
	15 50	0005	23.9	6.4		2253	7.90	104	0.020K	0.200	0.020K	0.002
	15 50	0012	23.5	4.6		2204	7.90	102	0.040	0.300	0.030	0.003
75/10/02	15 00	0000	18.8	6.6	15	1617	8.20	106	0.020K	0.500	0.040	0.004
	15 00	0005	18.8	7.8		1616	8.20	108	0.020K	0.600	0.040	0.002

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCOT LT REMNING PERCENT
75/05/01	11 00	0000	0.032	2.0	
	11 00	0005	0.014		
	11 00	0015	0.015		
	11 00	0025	0.014		
75/08/20	15 50	0000	0.027	8.9	30
	15 50	0005	0.036		
	15 50	0012	0.040		
75/10/02	15 00	0000	0.035	10.7	30
	15 00	0005	0.050		

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

350103
34 38 52.0 104 23 25.0 3
ALAMOGORDO
35011 NEW MEXICO

/TYPA/AMBNT/LAKE

11EPALES 760109 04001002
0016 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/05/01	11 25	0000	13.5	9.2	26	2018	8.00	119	0.020K	0.300	0.020K	0.004
	11 25	0005	13.5	8.0		2020	7.90	117	0.030	0.300	0.040	0.004
	11 25	0015	13.5	8.2		2019	8.00	117	0.030	0.300	0.020	0.003
75/08/20	16 15	0000	25.3	8.2	30	2305	8.20	97	0.020K	0.300	0.020K	0.003
	16 15	0005	24.8	7.4		2245	8.10	100	0.020	0.300	0.020K	0.005
	16 15	0013	22.0	4.4		2135	7.90	107	0.080	0.400	0.020K	0.003
75/10/02	14 30	0000	18.9	7.8	30	1567	8.20	123	0.040	0.400	0.040	0.003
	14 30	0005	18.8	7.6		1566	8.20	122	0.030	0.400	0.040	0.002
	14 30	0011	18.6	7.4		1553	8.20	122	0.020	0.400	0.040	0.002

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT RFMNING PERCENT
75/05/01	11 25	0000	0.017	1.9	
	11 25	0005	0.016		
	11 25	0015	0.018		
75/08/20	16 15	0000	0.031	5.1	
	16 15	0005	0.036		
	16 15	0013	0.039		
75/10/02	14 30	0000	0.051	8.8	
	14 30	0005	0.025		
	14 30	0011	0.026		

K VALUE KNOWN TO BE LESS THAN INDICATED

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

3501A1
34 36 40.0 104 23 05.0 4
PECOS RIVER
35 7.5 ALAMGRDO DAM
O/ALAMOGORDO RESERVOIR 120891
BNK BELO DAM .9 MI SE RT 203 JCT
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/12/07	12	30	0.130	0.400	0.032	0.025	
75/01/09	12	10	0.124	2.650	0.051	0.008	0.030
75/02/14	14	20	0.072	0.300	0.016	0.005	0.030
75/03/13	12	00	0.055	0.600	0.040	0.010	0.030
75/04/07	15	55	0.020	0.300	0.040	0.005	0.050
75/04/29	15	30	0.010	2.300	0.055	0.010	0.020
75/05/12	14	40	0.020	0.200	0.025	0.005K	0.020
75/05/28	16	00	0.030	0.475	0.040	0.010	0.035
75/06/17	17	00	0.015	0.400	0.050	0.005	0.030
75/07/10	13	15	0.015	0.700	0.125	0.015	0.090
75/08/13	12	45	0.030	0.550	0.095	0.010	0.100
75/09/16	14	50	0.110	0.400	0.067	0.010	0.060
75/10/20	18	00	0.035	0.400	0.065	0.010	0.060
75/11/11	12	00	0.025	0.400	0.007	0.005	0.030

K VALUE KNOWN TO BE LESS
THAN INDICATED

PRESENT APPLICATIONS AND STATISTICAL ANALYSIS OF WATER QUALITY DATA
U.S. ENVIRONMENTAL PROTECTION AGENCY

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

350142
34 43 48.0 104 31 28.0 4
PECOS RIVER
35 7.5 OJO NEGRO CK
T/ALAMOGORDO RESERVOIR 120891
RNK # OF END DRT RD 5.5 MI S RT 84 JCT
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/12/07	14	00	0.030	0.800	0.010		0.040
75/01/09	11	20	0.072	0.300	0.010	0.015	0.040
75/02/14	13	30	0.008	0.200	0.008K	0.010	0.020
75/03/13	11	05	0.090	2.300	0.075	0.025	0.600
75/04/07	15	10	0.005	0.150	0.030	0.005	0.070
75/04/29	14	00	0.170	4.100	0.260	0.010	1.100
75/05/12	12	40	0.115	0.600	0.030	0.030	0.250
75/05/28	13	15	0.125	1.150	0.025	0.030	0.500
75/06/17	14	00	0.060	0.700	0.030	0.025	0.210
75/07/10	19	55	0.025	0.450	0.010	0.015	0.120
75/08/13	11	15	0.030	0.300	0.010	0.010	0.110
75/09/16	14	10	0.125	2.200	0.010	0.030	0.930
75/10/20	16	30	0.005	0.500	0.020	0.005	0.050
75/11/12	11	00	0.025	0.300	0.025	0.010	0.050

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 77/02/14
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

/AMENT/ST-EAM

3501AA TF3501AA 0002500
34 55 40.0 104 40 50.0 4
SANTA ROSA
35 7.5 SANTA ROSA
T/ALAMOGORDO RES 120491
LOS TANOS CREEK TO PECOS RIVER
11EMALES 00001006
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 N02&N03 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/12/03	11 00								
CP(T)-			0.720	33.500	19.000	7.900	10.500	0.161	0.161
74/12/03	16 00								
75/01/02	10 00								
CP(T)-			0.240	37.500	19.000	4.900	9.900	0.268	0.268
75/01/02	15 00								
75/02/03	11 00								
CP(T)-			0.400	21.000	19.000	7.600	8.600	0.268	0.268
75/02/03	15 00								
75/03/03	11 00								
CP(T)-			0.080	36.000			11.500	0.041	0.041
75/03/03	15 00								
75/04/01	11 00								
CP(T)-			0.240	43.000	23.000	7.700	15.500	0.161	0.161
75/04/01	15 00								
75/05/01	11 00								
CP(T)-			0.200	43.000	22.000	6.000	13.500	0.163	0.161
75/05/01	15 00								
75/06/02	11 00								
CP(T)-			0.050	38.000	25.000	2.580	2.900	0.161	0.161
75/06/02	15 00								
75/07/03	11 00								
CP(T)-			4.730	25.000	9.800	2.800	8.000	0.343	0.343
75/07/03	15 00								
75/10/31	11 00								
CP(T)-			13.000	22.000	7.600	5.700	7.700	0.364	0.301
75/10/31	15 00								
76/01/08	08 00								
CP(T)-			0.850	43.000	27.000	4.100	10.500	0.333	0.301
76/01/08	14 00								
76/02/11	11 00								
CP(T)-			0.150	42.000	23.600	1.200	11.000	0.045	0.045
76/02/11	15 00								

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1975

STATE OF NEW MEXICO

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of New Mexico lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in µg/l. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 500. Similarly, minimum dissolved oxygen values are subtracted from 15 to create table entries.

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0812	NAVAJO RESERVOIR	0.025	0.130	420.928	2.164	11.200	0.009
3501	ALAMOGORDO	0.025	0.050	469.667	5.867	10.600	0.003
3502	BLUE WATER LAKE	0.036	0.140	480.125	3.867	11.400	0.012
3503	CONCHAS RESERVOIR	0.020	0.040	451.833	3.275	14.400	0.004
3504	EAGLE NEST LAKE	0.181	0.070	455.750	13.357	14.400	0.132
3505	ELEPHANT BUTTE RESERVOIR	0.083	0.110	475.750	6.758	14.200	0.052
3506	EL VADO RESERVOIR	0.034	0.140	466.444	2.189	12.600	0.014
3507	LAKE MACMILLAN	0.097	0.045	489.778	14.133	10.100	0.009
3509	UTE RESERVOIR	0.021	0.040	448.750	3.242	13.800	0.004

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0812	NAVAJO RESERVOIR	63 (5)	25 (2)	100 (8)	100 (8)	75 (6)	56 (4)
3501	ALAMOGORDO	75 (6)	63 (5)	38 (3)	38 (3)	88 (7)	100 (8)
3502	BLUE WATER LAKE	38 (3)	6 (0)	13 (1)	50 (4)	63 (5)	38 (3)
3503	CONCHAS RESERVOIR	100 (8)	94 (7)	75 (6)	63 (5)	6 (0)	81 (6)
3504	EAGLE NEST LAKE	0 (0)	50 (4)	63 (5)	13 (1)	6 (0)	0 (0)
3505	ELEPHANT BUTTE RESERVOIR	25 (2)	38 (3)	25 (2)	25 (2)	25 (2)	13 (1)
3506	EL VADO RESERVOIR	50 (4)	6 (0)	50 (4)	88 (7)	50 (4)	25 (2)
3507	LAKE MACMILLAN	13 (1)	75 (6)	0 (0)	0 (0)	100 (8)	56 (4)
3509	UTE RESERVOIR	88 (7)	94 (7)	88 (7)	75 (6)	38 (3)	81 (6)